

CLAIMS

1. An exposure apparatus which exposes a substrate by radiating an exposure light beam onto the substrate through a liquid, the exposure apparatus comprising:

a substrate stage which has a substrate-holding member for holding the substrate and which is movable while holding the substrate by the aid of the substrate-holding member; and

a temperature adjustment system which performs temperature adjustment for the substrate-holding member.

2. The exposure apparatus according to claim 1, wherein the temperature adjustment system performs the temperature adjustment for the substrate-holding member so that heat transfer is reduced between the substrate and the liquid on the substrate.

3. The exposure apparatus according to claim 1, wherein the temperature adjustment system performs the temperature adjustment for the substrate-holding member so that no temperature change of the liquid is caused by contact between the liquid and the substrate.

4. The exposure apparatus according to claim 3, wherein the temperature adjustment system performs the

temperature adjustment for the substrate-holding member so that no temperature distribution is generated in the liquid.

5. The exposure apparatus according to claim 3, further comprising a surface position-detecting unit which detects surface position information about a surface of the substrate by emitting a detecting light beam onto the substrate through the liquid and receiving a reflected light beam from the substrate through the liquid, wherein the temperature adjustment system performs the temperature adjustment for the substrate-holding member to suppress measurement error of the surface position-detecting unit due to the temperature change of the liquid.

6. The exposure apparatus according to claim 1, wherein the temperature adjustment system performs the temperature adjustment for the substrate-holding member so that no temperature change of the substrate is caused by contact between the liquid and the substrate.

7. The exposure apparatus according to claim 6, further comprising a mark-detecting system which detects an alignment mark on the substrate not through the liquid, wherein the temperature adjustment system performs the temperature adjustment for the substrate-holding member so

that a temperature of the substrate is not changed by the contact between the liquid and the substrate after detecting the mark by the mark-detecting system.

8. The exposure apparatus according to claim 1, wherein the temperature adjustment system uses a liquid which is same as the liquid to be supplied onto the substrate to perform the temperature adjustment for the substrate-holding member.

9. The exposure apparatus according to claim 1, wherein the temperature adjustment system performs the temperature adjustment for the substrate-holding member depending on a temperature of the liquid to be supplied onto the substrate.

10. The exposure apparatus according to claim 1, further comprising a temperature sensor which measures a temperature of the substrate-holding member.

11. The exposure apparatus according to claim 1, wherein the temperature adjustment system also performs temperature adjustment for an optical member through which the exposure light beam passes, in a state in which the optical member makes contact with the liquid.

12. The exposure apparatus according to claim 1, wherein the temperature adjustment system also performs temperature adjustment for the liquid.

13. The exposure apparatus according to claim 12, wherein the temperature adjustment system performs the temperature adjustment for the liquid, an optical member, and the substrate-holding member so that the liquid, the optical member, and the substrate have substantially same temperature.

14. An exposure apparatus which exposes a substrate by radiating an exposure light beam onto the substrate through a liquid, the exposure apparatus comprising:

a temperature adjustment system which performs temperature adjustment for an optical member through which the exposure light beam passes in a state in which the optical member makes contact with the liquid.

15. The exposure apparatus according to claim 14, wherein the temperature adjustment system performs the temperature adjustment for the optical member so that heat transfer is reduced between the liquid and the optical member.

16. The exposure apparatus according to claim 14,

wherein the temperature adjustment system performs the temperature adjustment for the optical member so that no temperature change of the liquid is caused by contact between the liquid and the optical member.

17. The exposure apparatus according to claim 16, wherein the temperature adjustment system performs the temperature adjustment for the optical member so that no temperature distribution is generated in the liquid.

18. The exposure apparatus according to claim 14, further comprising a temperature sensor which measures a temperature of the optical member.

19. The exposure apparatus according to claim 1 or 14, further comprising:

a projection optical system which projects an image of a pattern onto the substrate through the liquid; and

a temperature sensor which measures a temperature of the liquid supplied to an image plane side of the projection optical system.

20. The exposure apparatus according to claim 14, further comprising a surface position-detecting unit which detects surface position information about a surface of the substrate by emitting a detecting light beam onto the

substrate through the liquid and receiving a reflected light beam from the substrate through the liquid, wherein the temperature adjustment system performs the temperature adjustment for the optical member to suppress measurement error of the surface position-detecting unit due to temperature change of the liquid.

21. The exposure apparatus according to claim 14, wherein the temperature adjustment system performs the temperature adjustment for the optical member so that no temperature change of the optical member is caused by contact between the liquid and the optical member.

22. The exposure apparatus according to claim 14, wherein the temperature adjustment system uses a liquid which is same as the liquid to be supplied onto the substrate to perform the temperature adjustment for the optical member.

23. The exposure apparatus according to claim 14, wherein the temperature adjustment system performs the temperature adjustment for the optical member depending on a temperature of the liquid to be supplied onto the substrate.

24. The exposure apparatus according to claim 14,

wherein the temperature adjustment system also performs temperature adjustment for the liquid.

25. An exposure apparatus which exposes a substrate by radiating an exposure light beam onto the substrate through a liquid, the exposure apparatus comprising:

a substrate stage which is movable while holding the substrate and which has a member forming a flat portion around the substrate; and

a temperature adjustment system which performs temperature adjustment for the member forming the flat portion.

26. The exposure apparatus according to claim 25, wherein the flat portion is substantially flush with a surface of the substrate held by the substrate stage.

27. The exposure apparatus according to claim 25, wherein the member forming the flat portion includes a measuring member which is arranged around the substrate.

28. The exposure apparatus according to claim 25, wherein the temperature adjustment system performs the temperature adjustment so that no temperature change of the member forming the flat portion is caused.

29. The exposure apparatus according to claim 25, wherein the temperature adjustment system performs the temperature adjustment for the member forming the flat portion to suppress temperature change of the liquid on the flat portion.

30. An exposure apparatus which exposes a substrate by radiating an exposure light beam onto the substrate through a liquid, the exposure apparatus comprising:

- a first substrate stage which has a substrate-holding member for holding the substrate and which is movable while holding the substrate by the aid of the substrate-holding member;

- a second substrate stage which has a substrate-holding member for holding the substrate and which is movable while holding the substrate by the aid of the substrate-holding member;

- a measuring station which performs measurement for the substrate held by one of the stages;

- an exposure station which performs exposure for the substrate held by the other of the stages; and

- temperature adjustment systems which are provided for the first substrate stage and the second substrate stage respectively and which perform temperature adjustment for the substrate-holding member of each of the stages in the measuring station.

31. The exposure apparatus according to claim 30, wherein the measurement for the substrate in the measuring station includes measurement of surface position information about a surface of the substrate.

32. The exposure apparatus according to claim 30, wherein the measurement for the substrate in the measuring station includes detection of an alignment mark on the substrate.

33. The exposure apparatus according to claim 30, wherein the temperature adjustment system performs the temperature adjustment for the substrate-holding member before performing the measurement for the substrate.

34. The exposure apparatus according to claim 30, wherein:

the exposure station is provided with a liquid supply mechanism which supplies the liquid onto the substrate; and

the temperature adjustment system performs the temperature adjustment for the substrate-holding member depending on a temperature of the liquid supplied from the liquid supply mechanism.

35. The exposure apparatus according to claim 30,

wherein the temperature adjustment system performs, after the measurement for the substrate in the measuring station, the temperature adjustment for the substrate-holding member to suppress temperature change of the substrate caused by contact with the liquid supplied onto the substrate in the exposure station.

36. The exposure apparatus according to any one of claims 1, 14, 25, and 30, further comprising a projection optical system which projects an image of a pattern onto the substrate through the liquid.

37. An exposure apparatus which exposes a substrate by radiating an exposure light beam onto the substrate through a liquid, the exposure apparatus comprising:

a liquid supply mechanism which supplies the liquid;
and

a temperature sensor which measures a temperature of an object that makes contact with the liquid supplied from the liquid supply mechanism, wherein:

the liquid supply mechanism adjusts a temperature of the liquid to be supplied on the basis of a measurement result obtained by the temperature sensor.

38. The exposure apparatus according to claim 37, further comprising:

a projection optical system which projects an image of a pattern onto the substrate through the liquid supplied from the liquid supply mechanism, wherein:

the liquid supply mechanism supplies the liquid to an image plane side of the projection optical system;

the temperature sensor measures the temperature of the object which makes contact with the liquid supplied from the liquid supply mechanism to the image plane side of the projection optical system; and

the liquid supply mechanism adjusts the temperature of the liquid to be supplied the image plane side of the projection optical system on the basis of the measurement result obtained by the temperature sensor.

39. The exposure apparatus according to claim 37, wherein the object includes the substrate.

40. The exposure apparatus according to claim 37, further comprising:

a projection optical system which projects an image of a pattern onto the substrate through the liquid supplied from the liquid supply mechanism, wherein:

the object includes a part of optical members of the projection optical system.

41. The exposure apparatus according to claim 37,

further comprising:

a substrate stage which is movable while holding the substrate, wherein:

the object includes a member which forms at least a part of an upper surface of the substrate stage.

42. The exposure apparatus according to claim 41, wherein the member, which forms at least the part of the upper surface of the substrate stage, includes a measuring member which is provided in the substrate stage.

43. The exposure apparatus according to claim 37, wherein the temperature-adjusting unit adjusts the temperature of the liquid to be supplied so that the temperature of the liquid to be supplied is substantially same as the temperature of the object.

44. A method for producing a device, comprising using the exposure apparatus as defined in any one of claims 1, 14, 25, 30, and 37.

45. An exposure method for exposing a substrate through a liquid, the exposure method comprising:

adjusting a temperature of the substrate in consideration of a temperature of the liquid before starting exposure for the substrate; and

exposing the substrate by radiating an exposure light beam onto the substrate through the liquid.

46. The exposure method according to claim 45, wherein the exposure light beam is radiated onto the substrate via a projection optical system and the liquid to expose the substrate.

47. The exposure method according to claim 45, wherein the temperature of the substrate is adjusted before loading the substrate on a substrate stage which is movable while holding the substrate during the exposure for the substrate.

48. The exposure method according to claim 45, wherein the temperature of the substrate is adjusted after loading the substrate on a substrate stage which is movable while holding the substrate during the exposure for the substrate.

49. The exposure method according to claim 48, wherein the liquid, which is to be used for the exposure for the substrate, is supplied onto the substrate loaded on the substrate stage to adjust the temperature of the substrate.

50. The exposure method according to claim 49, wherein the temperature of the substrate is adjusted before detecting an alignment mark on the substrate loaded on the substrate stage.

51. The exposure method according to claim 45, wherein the liquid, which is to be used for the exposure for the substrate, is used to adjust the temperature of the substrate.

52. The exposure method according to claim 47, wherein the temperature of the substrate is adjusted before loading the substrate on the substrate stage so that the temperature change in the liquid is small when the substrate and the liquid make contact with each other.

53. The exposure method according to claim 52, wherein the temperature of the substrate is adjusted before loading the substrate on the substrate stage so that the temperature change in the substrate is small when the substrate is loaded on the substrate stage.

54. A method for producing a device, comprising using the exposure method as defined in claim 45.

55. An exposure method for exposing a substrate

through a liquid, the exposure method comprising:

adjusting a temperature of an object which includes the substrate and makes contact with the liquid, on the basis of a predetermined temperature; and

exposing the substrate through the liquid which has the predetermined temperature.

56. The exposure method according to claim 55, further comprising measuring the temperature of the object.

57. The exposure method according to claim 56, wherein the temperature of the object is adjusted on the basis of the predetermined temperature and the measured temperature of the object.

58. The exposure method according to claim 55, wherein the substrate is exposed through the liquid having the predetermined temperature while adjusting the temperature of the object which makes contact with the liquid on the basis of the predetermined temperature.

59. An exposure method for exposing a substrate by radiating an exposure light beam onto the substrate through a liquid, the exposure method comprising:

supplying the liquid; and

adjusting a temperature of the liquid to be supplied,

on the basis of a temperature of an object which makes contact with the supplied liquid.

60. The exposure method according to claim 59, wherein:

the exposure light beam is radiated onto the substrate via a projection optical system; and

the object is a part of the substrate or an optical member of the projection optical system.

61. The exposure method according to claim 59, further comprising holding the substrate on a substrate stage, wherein the object is a member which is provided on an upper surface of the substrate stage.